We claim:

1. A method for optimizing a wireless electromagnetic communications network, comprising:

a wireless electromagnetic communications network, comprising

a set of nodes, said set of nodes further comprising,

at least a first subset wherein each node is MIMO-capable, comprising:

a spatially diverse antennae array of M antennae, where M $\geq$ two,
a transceiver for each antenna in said spatially diverse antennae array,
means for digital signal processing to convert analog radio signals into digital signals and digital signals into analog radio signals,
means for coding and decoding data, symbols, and control information into and from digital signals,
diversity capability means for transmission and reception of said analog radio waves,
and,
means for input and output from and to a non-radio interface for digital signals;

said set of nodes being deployed according to design rules that prefer meeting the following criteria:

said set of nodes further comprising two or more proper subsets of nodes, with a first proper subset being the transmit uplink / receive downlink set, and a second proper subset being the transmit downlink / receive uplink set;

each node in said set of nodes belonging to no more transmitting uplink or receiving uplink subsets than it has diversity capability means;

each node in a transmit uplink / receive downlink subset has no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability;

each node in a transmit downlink / receive uplink subset has no more nodes with which it will hold time and frequency coincident

communications in its field of view, than it has diversity capability;

each member of a transmit uplink / receive downlink subset cannot hold time and frequency coincident communications with any other member of that transmit uplink / receive downlink subset;

and,

each member of a transmit downlink / receive uplink subset cannot hold time and frequency coincident communications with any other member of that transmit downlink / receive uplink subset;

transmitting, in said wireless electromagnetic communications network, independent information from each node belonging to a first proper subset, to one or more receiving nodes belonging to a second proper subset that are viewable from the transmitting node;

processing independently, in said wireless electromagnetic communications network, at each receiving node belonging to said second proper subset, information transmitted from one or more nodes belonging to said first proper subset;

and,

dynamically adapting the diversity channels and said proper subsets to optimize said network.

2. A method as in claim 1, wherein dynamically adapting the diversity channels and said proper subsets to optimize said network further comprises:

using substantive null steering to minimize SINR between nodes transmitting and receiving information.

3. A method as in claim 1, wherein dynamically adapting the diversity channels and said proper subsets to optimize said network further comprises:

using max-SINR null- and beam-steering to minimize intra-network interference.

4. A method as in claim 1, wherein dynamically adapting the diversity channels and said proper subsets to optimize said network further comprises:

using MMSE null- and beam-steering to minimize intra-network interference.

5. A method as in claim 1, wherein dynamically adapting the diversity channels and said proper subsets to optimize said network further comprises:

designing the network such that reciprocal symmetry exists for each pairing of uplink receive and downlink receive proper subsets.

6. A method as in claim 1, wherein dynamically adapting the diversity channels and said proper subsets to optimize said network further comprises:

designing the network such that substantial reciprocal symmetry exists for each pairing of uplink receive and downlink receive proper subsets.

7. A method as in claim 1, wherein the network uses TDD communication protocols.

8. A method as in claim 1, wherein the network uses FDD communication protocols.

9. A method as in claim 3, wherein the network uses simplex communication protocols.

10. A method as in claim 1, wherein the network uses random access packets, and receive and transmit operations are all carried out on the same frequency channels for each link.

11. A method as in claim 1, wherein dynamically adapting the diversity channels and said proper subsets to optimize said network further comprises

if the received interference is spatially white in both link directions, setting

$g_1(a)\ \alpha\ w^*{}_2 q$ and $g_2(q)\ \alpha\ w^*{}_1(q)$ at both ends of the link, where $\{g_2(q),\ w_1(q)\}$ are the linear transmit and receive weights used in the downlink;

but if the received interference is not spatially white in both link directions, constraining $\{g_1(q)\}$ and $\{g_2(q)\}$ to preferentially satisfy:

$$\sum_{q=1}^{Q_{21}} g^T{}_1(q) R_{i1i1}[n_1(q)] g^*{}_1(q) = \sum_{n=1}^{N_1} \mathrm{Tr}\{R_{i1i1}(n)\} = M_1 R_1$$

$$\sum_{q=1}^{Q_{12}} g^T{}_2(q) R_{i2i2}[n_2(q)] g^*{}_2(q) = \sum_{n=1}^{N_2} \mathrm{Tr}\{R_{i2i2}(n)\} = M_2 R_2.$$

12. A method as in claim 6, wherein the step of designing the network such that substantial reciprocal symmetry exists for the uplink and downlink channels further comprises:

if the received interference is spatially white in both link directions, setting

$g_1(a)\ \alpha\ w^*{}_2q$ and $g_2(q)\ \alpha\ w^*{}_1(q)$ at both ends of the link, where $\{g_2(q), w_1(q)\}$ are the linear transmit and receive weights used in the downlink;

but if the received interference is not spatially white in both link directions, constraining $\{g_1(q)\}$ and $\{g_2(q)\}$ to preferentially satisfy:

$$\sum_{q=1}^{Q_{21}} g^T{}_1(q)R_{i1i1}[n_1(q)]g^*{}_1(q) = \sum_{n=1}^{N_1} Tr\{R_{i1i1}(n)\} = M_1R_1$$

$$\sum_{q=1}^{Q_{12}} g^T{}_2(q)R_{i2i2}[n_2(q)]g^*{}_2(q) = \sum_{n=1}^{N_2} Tr\{R_{i2i2}(n)\} = M_2R_2.$$

13. A method as in claim 1, wherein the means for digital signal processing in said first subset of MIMO-capable nodes further comprises:

an ADC bank for downconversion of received RF signals into digital signals;
a MT DEMOD element for multitone demodulation, separating the received signal into distinct tones and splitting them into 1 through $K_{feed}$ FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT DEMOD element further comprising
- a Comb element with a multiple of 2 filter capable of operating on a 128-bit sample; and,
- an FFT element with a 1,024 real-IF function;

a Mapping element for mapping the demodulated multitone signals into a 426 active receive bins, wherein
- each bin covers a bandwidth of 5.75MHz;
- each bin has an inner passband of 4.26MHz for a content envelope;
- each bin has an external buffer, up and down, of 745kHz;

each bin has 13 channels, CH0 through CH12, each channel having 320 kHz and 32 tones, T0 through T31, each tone being 10kHz, with the inner 30 tones being used information bearing and T0 and T31 being reserved; each signal being 100μs, with 12.5μs at each end thereof at the front and rear end thereof forming respectively a cyclic prefix and cyclic suffix buffer to punctuate successive signals; and,

a symbol-decoding element for interpretation of the symbols embedded in the signal.

14. A method as in claim 1, wherein dynamically adapting the diversity channels and said proper subsets to optimize said network further comprises

using at each node the receive combiner weights as transmit distribution weights during subsequent transmission operations, so that the network is preferentially designed and constrained such that each link is substantially reciprocal, such that the ad hoc network capacity measure can be made equal in both link directions by setting at both ends of the link:

$$g_2(q)\ \alpha\ w^*{}_2(k,q) \text{ and } g_1(k,q)\ \alpha\ w^*{}_1(k,q),$$

where $\{g_2(k,q),\ w_1(k,q)\}$ are the linear transmit and receive weights to transmit data $d_2(k,q)$ from node $n_2(q)$ to node $n_1(q)$ over channel $k$ in the downlink, and where $\{\mathbf{g}_1(k,q),\mathbf{w}_2(k,q)\}$ are the linear transmit and receive weights used to transmit data $d_1(k,q)$ from node $n_1(q)$ back to node $n_2(q)$ over equivalent channel $k$ in the uplink.

15. A method as in claim 1, wherein the step of each node in a transmit downlink / receive uplink subset having no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability further comprises:

designing the topological, physical layout of nodes to enforce this constraint within the node's diversity channel means limitations.

16. A method as in claim 1, wherein the step of each node in a transmit uplink / receive downlink subset having no more nodes with which it will hold time and

frequency coincident communications in its field of view, than it has diversity capability further comprises:

designing the topological, physical layout of nodes to enforce this constraint within the node's diversity channel means limitations.

17. A method as in claim 1, dynamically adapting the diversity channels and said proper subsets to optimize said network further comprises:

allowing a proper subset to send redundant data transmissions over multiple frequency channels to another proper subset.

18. A method as in claim 1, dynamically adapting the diversity channels and said proper subsets to optimize said network further comprises:

allowing a proper subset to send redundant data transmissions over multiple simultaneous or differential time slots to another proper subset.

19. A method as in claim 1, wherein said transmitting proper subset and receiving proper subset diversity capability means for transmission and reception of said analog radio waves further comprise:

spatial diversity of antennae.

19. A method as in claim 1, wherein said transmitting proper subset and receiving proper subset diversity capability means for transmission and reception of said analog radio waves further comprise:

polarization diversity of antennae.

20. A method as in claim 1, wherein said transmitting proper subset and receiving proper subset diversity capability means for transmission and reception of said analog radio waves further comprise:

any combination of temporal, spatial, and polarization diversity of antennae.

21. A method for optimizing a wireless electromagnetic communications network, comprising:

a wireless electromagnetic communications network, comprising

a set of nodes, said set further comprising,

at least a first subset of MIMO-capable nodes, each MIMO-capable node comprising:

a spatially diverse antennae array of M antennae, where M $\geq$ two, said antennae array being polarization diverse, and circularly symmetric, and providing 1-to-M RF feeds;

a transceiver for each antenna in said array, said transceiver further comprising

a Butler Mode Forming element, providing spatial signature separation with a FFT-LS algorithm, reciprocally forming a transmission with shared receiver feeds, such that the number of modes out equals the numbers of antennae, establishing such as an ordered set with decreasing energy, further comprising:

a dual-polarization element for splitting the modes into positive and negative polarities with opposite and orthogonal polarizations, that can work with circular polarizations, and

a dual-polarized link CODEC;

a transmission/reception switch comprising,

a vector OFDM receiver element;

a vector OFDM transmitter element;

a LNA bank for a receive signal, said LNA Bank also instantiating low noise characteristics for a transmit signal;

a PA bank for the transmit signal that receives the low noise characteristics for said transmit signal from said LNA bank;

an AGC for said LNA bank and PA bank;

a controller element for said transmission/reception switch enabling baseband link distribution of the energy over the multiple RF feeds on each channel to steer up to $K_{feed}$ beams and nulls independently on each FDMA channel;

a Frequency Translator;

a timing synchronization element controlling said controller element;

further comprising a system clock,

a universal Time signal element;

GPS;

a multimode power management element and algorithm;

and,

a LOs element;

said vector OFDMreceiver element comprising

an ADC bank for downconversion of received RF signals into digital signals;

a MT DEMOD element for multitone demodulation, separating the received signal into distinct tones and splitting them into 1 through $K_{feed}$ FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT DEMOD element further comprising

a Comb element with a multiple of 2 filter capable of operating on a 128-bit sample; and,

an FFT element with a 1,024 real-IF function;

a Mapping element for mapping the demodulated multitone signals into a 426 active receive bins, wherein

each bin covers a bandwidth of 5.75MHz;

each bin has an inner passband of 4.26MHz for a content envelope;

each bin has an external buffer, up and down, of 745kHz;

each bin has 13 channels, CH0 through CH12, each channel having 320 kHz and 32 tones, T0 through T31, each tone being 10kHz, with the inner 30 tones being used information bearing and T0 and T31 being reserved;

each signal being 100μs, with 12.5μs at each end thereof at the front and rear end thereof forming respectively a cyclic prefix and cyclic suffix buffer to punctuate successive signals;

a MUX element for timing modification capable of element-wise multiplication across the signal, which halves the number of bins and tones but repeats the signal for high-quality needs;

a link CODEC, which separates each FDMA channel into 1 through M links, further comprising

- a SOVA bit recovery element;
- an error coding element;
- an error detection element;
- an ITI remove element;
- a tone equalization element; and,
- a package fragment retransmission element;

a multilink diversity combining element, using a multilink Rx weight adaptation algorithm for Rx signal weights $W(k)$ to adapt transmission gains $G(k)$ for each channel $k$;

an equalization algorithm, taking the signal from said multilink diversity combining element and controlling a delay removal element;

said delay removal element separating signal content from imposed pseudodelay and experienced environmental signal delay, and passing the content-bearing signal to a symbol-decoding element;

said symbol-decoding element for interpretation of the symbols embedded in the signal, further comprising:

- an element for delay gating;
- a QAM element; and
- a PSK element;

said vector OFDM transmitter element comprising:

a DAC bank for conversion of digital signals into RF signals for transmission;

a MT MOD element for multitone modulation, combining and joining the signal to be transmitted from 1 through $K_{feed}$ FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT MOD element further comprising

- a Comb element with a multiple of 2 filter capable of operating on a 128-bit sample; and,

- an IFFT element with a 1,024 real-IF function;

a Mapping element for mapping the modulated multitone signals from 426 active transmit bins, wherein

- each bin covers a bandwidth of 5.75MHz;
- each bin has an inner passband of 4.26MHz for a content envelope;
- each bin has an external buffer, up and down, of 745kHz;
- each bin has 13 channels, CH0 through CH12, each channel having 320 kHz and 32 tones, T0 through T31, each tone being 10kHz, with the inner 30 tones being used information bearing and T0 and T31 being reserved;
- each signal being 100μs, with 12.5μs at each end thereof at the front and rear end thereof forming respectively a cyclic prefix and cyclic suffix buffer to punctuate successive signals;

a MUX element for timing modification capable of element-wise multiplication across the signal, which halves the number of bins and tones but repeats the signal for high-quality needs;

a symbol-coding element for embedding the symbols to be interpreted by the receiver in the signal, further comprising:

- an element for delay gating;
- a QAM element; and
- a PSK element;

a link CODEC, which aggregates each FDMA channel from 1 through M links, further comprising

- a SOVA bit recovery element;
- an error coding element;
- an error detection element;
- an ITI remove element;
- a tone equalization element; and,
- a package fragment retransmission element;

a multilink diversity distribution element, using a multilink Tx weight adaptation algorithm for Tx signal weights to adapt transmission gains $G(k)$ for each channel $k$, such that $g(q;k) \ \alpha \ w^*(q;k)$;

a pilot symbol CODEC element that integrates with said FFT-LS algorithm a link separation, a pilot and data signal elements sorting, a link detection, multilink combination, and equalizer weight calculation operations;
means for diversity transmission and reception,
and,
means for input and output from and to a non-radio interface;

said set of nodes being deployed according to design rules that prefer meeting the following criteria:

said set of nodes further comprising two or more proper subsets of nodes, with a first proper subset being the transmit uplink / receive downlink set, and a second proper subset being the transmit downlink / receive uplink set;

each node in said set of nodes belonging to no more transmitting uplink or receiving uplink subsets than it has diversity capability means;

each node in a transmit uplink / receive downlink subset has no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability;

each node in a transmit downlink / receive uplink subset has no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability;

each member of a transmit uplink / receive downlink subset cannot hold time and frequency coincident communications with any other member of that transmit uplink / receive downlink subset;

and,

each member of a transmit downlink / receive uplink subset cannot hold time and frequency coincident communications with any other member of that transmit downlink / receive uplink subset;

transmitting, in said wireless electromagnetic communications network, independent information from each node belonging to a first proper subset, to one or more receiving nodes belonging to a second proper subset that are viewable from the transmitting node;

processing independently, in said wireless electromagnetic communications network, at each receiving node belonging to said second proper subset, information transmitted from one or more nodes belonging to said first proper subset;

and,

designing the network such that substantially reciprocal symmetry exists for the uplink and downlink channels by,

if the received interference is spatially white in both link directions, setting

$g_1(a)\ \alpha\ w^*{}_2q$ and $g_2(q)\ \alpha\ w^*{}_1(q)$ at both ends of the link, where $\{g_2(q),\ w_1(q)\}$ are the linear transmit and receive weights used in the downlink;

but if the received interference is not spatially white in both link directions, constraining $\{g_1(q)\}$ and $\{g_2(q)\}$ to satisfy:

$$\sum_{q=1}^{Q_{21}} g^T{}_1(q)R_{i1i1}[n_1(q)]g^*{}_1(q) = \sum_{n=1}^{N_1} Tr\{R_{i1i1}(n)\} = M_1R_1$$

$$\sum_{q=1}^{Q_{12}} g^T{}_2(q)R_{i2i2}[n_2(q)]g^*{}_2(q) = \sum_{N_2}^{n=1} Tr\{R_{i2i2}(n)\} = M_2R_2,$$

using any standard communications protocol, including TDD, FDD, simplex,

and,

optimizing the network by dynamically adapting the diversity channels between nodes of said transmitting and receiving subsets.

22. A method as in claim 1, wherein said first subset has a timing synchronization element uisng a universal timing standard:

23. A method as in claim 22, wherein said universal timing standard is

GPS

24. A method as in claim 22, wherein said timing synchronization means further comprises:

a network timing signal

25. A method as in claim 22, wherein said timing synchronization means further comprises:

any combination of GPS and network timing signal

26.

BEGIN LEGO AS PART OF INVENTION

31. A method as in claim 1, wherein

LEGO optimization means.

32. A method as in claim 4, wherein

LEGO element.

33. A method as in claim 21, wherein said first subset of nodes further comprises

LEGO element

and said network further comprises

LEGO Optimization means.

34.

BEGIN APPARATUS CLAIMS

50. A wireless electromagnetic communications network, comprising:

a wireless electromagnetic communications network, comprising

a set of nodes, said set further comprising,

at least a first subset wherein each node is MIMO-capable, comprising:

a spatially diverse antennae array of M antennae, where M $\geq$ two,
a transceiver for each antenna in said array,
means for digital signal processing,
means for coding and decoding data and symbols,
means for diversity transmission and reception,
and,
means for input and output from and to a non-radio interface;

said set of nodes further comprising one or more proper subsets of nodes, being at least one transmitting and at least one receiving subset, with said transmitting and receiving subsets having a topological arrangement whereby:

each node in a transmitting subset has no more nodes with which it will simultaneously communicate in its field of view, than it has number of antennae;

each node in a receiving subset has no more nodes with which it will simultaneously communicate in its field of view, than it can steer independent nulls to;

and,

each member of a non-proper subset cannot communicate with any other member of its non-proper subset;

transmitting independent information from each node in a first non-proper subset to one or more receiving nodes belonging to a second non-proper subset that are viewable from the transmitting node;

processing independently information transmitted to a receiving node in a second non-proper subset from one or more nodes in a first non-proper subset is independently by the receiving node;

and,

optimizing the network by dynamically adapting the diversity channels between nodes of said transmitting and receiving subsets.

PREFERRED EMBODIMENT: ALL THE DETAILS

90. A wireless electromagnetic communications network, comprising:

a set of nodes, said set further comprising,

at least a first subset wherein each node is MIMO-capable, comprising:

a spatially diverse antennae array of M antennae, where M $\geq$ two,
a transceiver for each antenna in said array,
13 means for digital signal processing,
14 means for coding and decoding data and symbols,
19 means for diversity transmission and reception,

pilot symbol coding & decoding element
timing synchronization element

and,
means for input and output from and to a non-radio interface;

said set of nodes further comprising two or more proper subsets of nodes, there being at least one transmitting and at least one receiving subset, with said transmitting and receiving subsets subset having a diversity arrangement whereby:

each node in a transmitting subset has no more nodes with which it will simultaneously communicate in its field of view, than it has number of antennae;

each node in a receiving subset has no more nodes with which it will simultaneously communicate in its field of view, than it can steer independent nulls to;

and,

each member of a non-proper subset cannot communicate with any other member of its non-proper subset over identical diversity channels;

each node in a first non-proper subset transmitting independent information to one or more receiving nodes belonging to a second non-proper subset that are viewable from the transmitting node;

each receiving node in said second non-proper subset processing independently information transmitted to a from one or more nodes in a first non-proper subset is independently by the receiving node;

using null steering to minimize SINR between nodes transmitting and receiving information;

designing the network such that substantially reciprocal symmetry exists for the uplink and downlink channels by,

if the received interference is spatially white in both link directions, setting

$g_1(a)\ \alpha\ w^*{}_2q$ and $g_2(q)\ \alpha\ w^*{}_1(q)$ at both ends of the link, where $\{g_2(q), w_1(q)\}$ are the linear transmit and receive weights used in the downlink;

but if the received interference is not spatially white in both link directions, constraining $\{g_1(q)\}$ and $\{g_2(q)\}$ to satisfy:

$$\sum_{q=1}^{Q_{21}} g^T{}_1(q) R_{i1i1}[n_1(q)] g^*{}_1(q) = \sum_{n=1}^{N_1} \mathrm{Tr}\{R_{i1i1}(n)\} = M_1 R_1$$

$$\sum_{q=1}^{Q_{12}} g^T{}_2(q)R_{i2i2}[n_2(q)]g^*{}_2(q) =$$

$$\sum_{N_2}^{n=1} Tr\{R_{i2i2}(n)\} = M_2R_2,$$

using any standard communications protocol, including TDD, FDD, simplex,

and,

optimizing the network by dynamically adapting the diversity channels between nodes of said transmitting and receiving subsets.

101. A wireless electromagnetic communications network as in claim 50:

wherein each node may further comprise a Butler Mode Forming element, to enable said node to ratchet the number of active antennae for a particular uplink or downlink operation up or down.

102. A wireless electromagnetic communications network as in claim 50:

wherein FFT algorithm is part of Pilot Tone

103. A wireless electromagnetic communications network as in claim 50:

incorporating dynamics-resistant multitone.

150. The use of a method as described in claim 1 for fixed wireless electromagnetic communications.

151. The use of an apparatus as described in claim 50 for fixed wireless electromagnetic communications.

152. The use of a method as described in claim 1 for mobile wireless electromagnetic communications.

153. The use of an apparatus as described in claim 50 for mobile wireless electromagnetic communications.

154. The use of a method as described in claim 1 for mapping operations using wireless electromagnetic communications.

155. The use of an apparatus as described in claim 50 for mapping operations using wireless electromagnetic communications.

154. The use of a method as described in claim 1 for a military wireless electromagnetic communications network.

155. The use of an apparatus as described in claim 50 for a military wireless electromagnetic communications network.

156. The use of a method as described in claim 1 for a military wireless electromagnetic communications network for battlefield operations.

157. The use of an apparatus as described in claim 50 for a military wireless electromagnetic communications network for battlefield operations.

158. The use of a method as described in claim 1 for a military wireless electromagnetic communications network for Back Edge of Battle Area (BEBA) operations.

159. The use of an apparatus as described in claim 50 for a military wireless electromagnetic communications network for Back Edge of Battle Area (BEBA) operations..

160. The use of a method as described in claim 1 for a wireless electromagnetic communications network for intruder detection operations.

161. The use of an apparatus as described in claim 50 for a wireless electromagnetic communications network for intruder detection operations..

162. The use of a method as described in claim 1 for a wireless electromagnetic communications network for logistical intercommunications.

163. The use of an apparatus as described in claim 50 for a wireless electromagnetic communications network for logistical intercommunications.

164. The use of a method as described in claim 1 in a wireless electromagnetic communications network for self-filtering spoofing signals.

165. The use of an apparatus as described in claim 50 for a wireless electromagnetic communications network for self-filtering spoofing signals..

166. The use of a method as described in claim 1 in a wireless electromagnetic communications network for airborne relay over the horizon.

165. The use of an apparatus as described in claim 50 for a wireless electromagnetic communications network for airborne relay over the horizon.

166. The use of a method as described in claim 1 in a wireless electromagnetic communications network for traffic control.

167 The use of a method as in claim 166, further comprising the use thereof for air traffic control

168. The use of a method as in claim 166, further comprising the use thereof for ground traffic control.

169. The use of a method as in claim 166, further comprising the use thereof for a mixture of ground and air traffic control.

170. The use of an apparatus as described in claim 50 for a wireless electromagnetic communications network for traffic control.

171 The use of an apparatus as in claim 170, further comprising the use thereof for air traffic control

172. The use of an apparatus as in claim 170, further comprising the use thereof for ground traffic control.

173. The use of an apparatus as in claim 170, further comprising the use thereof for a mixture of ground and air traffic control.

174. The use of a method as in claim 1 in a wireless electromagnetic communications network for emergency services.

175. The use of an apparatus as in claim 50 in a wireless electromagnetic communications network for emergency services.

176. The use of a method as in claim 1 in a wireless electromagnetic communications network for shared emergency communications without interference.

177. The use of an apparatus as in claim 50 in a wireless electromagnetic communications network for shared emergency communications without interference.

178. The use of a method as in claim 1 in a wireless electromagnetic communications network for positioning operations without interference.

179. The use of an apparatus as in claim 50 in a wireless electromagnetic communications network for positioning operations without interference.

180. The use of a method as in claim 1 in a wireless electromagnetic communications network for high reliabilty networks requiring graceful degradation despite environmental conditions or changes..

181. The use of an apparatus as in claim 50 in a wireless electromagnetic communications network for high reliabilty networks requiring graceful degradation despite environmental conditions or changes..

182. The use of a method as in claim 1 in a wireless electromagnetic communications network for a secure network requiring assurance against unauthorized intrusion.

183. The use of a method as in claim 1 in a wireless electromagnetic communications network for a secure network requiring message end-point assurance.

184. The use of a method as in claim 1 in a wireless electromagnetic communications network for a secure network requiring assurance against unauthorized intrusion and message end-point assurance.

185. The use of an apparatus as in claim 50 in a wireless electromagnetic communications network for a secure network requiring assurance against unauthorized intrusion.

186. The use of an apparatus as in claim 50 in a wireless electromagnetic communications network for a secure network requiring message end-point assurance.

187. The use of an apparatus as in claim 50 in a wireless electromagnetic communications network for a secure network requiring assurance against unauthorized intrusion and message end-point assurance.

188. The use of a method as in claim 1 in a cellular mobile radio service.

189. The use of an apparatus as in claim 50 in a cellular mobile radio service.

190. The use of a method as in claim 1 in a personal communication service.

191. The use of an apparatus as in claim 50 in a personal communication service.

192. The use of a method as in claim 1 in a private mobile radio service.

193. The use of an apparatus as in claim 50 in a private mobile radio service.

194. The use of a method as in claim 1 in a wireless LAN.

195. The use of an apparatus as in claim 50 in a wireless LAN.

196. The use of a method as in claim 1 in a fixed wireless access service.

197. The use of an apparatus as in claim 50 in a fixed wireless access service.

198. The use of a method as in claim 1 in a broadband wireless access service.

199. The use of an apparatus as in claim 50 in a broadband wireless access service.

200. The use of a method as in claim 1 in a municipal area network.

201. The use of an apparatus as in claim 50 in a municipal area network.

202. The use of a method as in claim 1 in a wide area network.

203. The use of an apparatus as in claim 50 in a wide area network.

204. The use of a method as in claim 1 in wireless backhaul.

205. The use of an apparatus as in claim 50 in wireless backhaul.

206. The use of a method as in claim 1 in wireless backhaul.

207. The use of an apparatus as in claim 50 in wireless backhaul.

208. The use of a method as in claim 1 in wireless SONET.

209. The use of an apparatus as in claim 50 in wireless SONET.

210. The use of a method as in claim 1 in wireless SONET.

211. The use of an apparatus as in claim 50 in wireless SONET.

212. The use of a method as in claim 1 in wireless Telematics.

213. The use of an apparatus as in claim 50 in wireless Telematics.